EARLY DEVELOPMENT OF *NOTOTHENIA NEGLECTA* FROM THE SCOTIA SEA, ANTARCTICA

by

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ABSTRACT. – The authors describe the culture of an Antarctic fish, *Notothenia neglecta*, in two separate field research stations. Their results demonstrate that development from fertilization to first hatching takes about 150 days at the colder locality (Signy Island) and 103 days at the warmer one (South Georgia). Newly hatched larval fish were 10-14 mm long.

RÉSUMÉ. – Les auteurs décrivent l'élevage d'un poisson antarctique, *Notothenia neglecta*, à deux stations scientifiques différentes. Leurs résultats montrent que le développement entre la fécondation et la première éclosion dure 150 jours à la station la plus froide (Signy Island) et 103 jours à la station la moins froide (Géorgie du Sud). Les larves nouvellement écloses mesurent 10-14 mm de long.

Research into the role of fish as components of the marine ecosystem in the Southern Ocean has been carried out as part of a research programme by the British Antarctic Survey (Bonner *et al*, 1978). The majority of the ichthyological studies have centred on the identification, growth, diet and distribution of fish species during the early part of their life history. The general sequence of the life history of many of the more common Antarctic Nototheniiform fish has been described (Hureau, 1970 ; Everson, 1977) and such parameters as fecundity, growth rate, age at maturity, spawning period and the seasonal variations in reproductive condition are reasonably well documented. Figure 1 illustrates a generalised life history for the Antarctic Nototheniiform fish, however, the larval life history and the development from fertilized egg to hatching is poorly known for Antarctic species.

This account describes the culture of *Notothenia neglecta* in two separate experiments at the BAS research stations at Signy Island, South Orkney Islands (60° 43'S, 45°38'W) and at Grytviken, South Georgia (54°17'S, 36°30'W).

N. neglecta is a common demersal species of fish at both localities and the life history is very similar to that of the closely related species *Notothenia rossii*. The adults mature and spawn over the continental shelf during May and June, the post-larval stages have been reported from the coastal waters of South Georgia during

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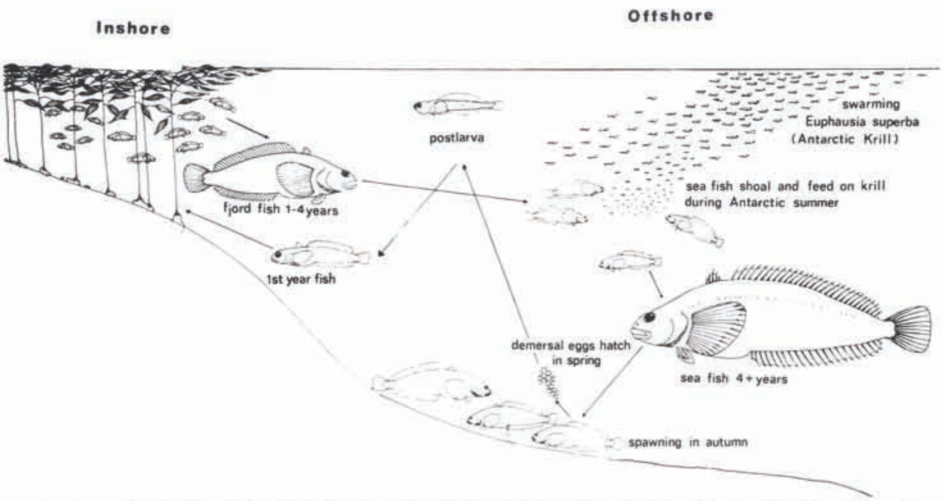

Fig. 1. – Generalised life history of Antarctic Nototheniiform fish based on *Notothenia rossii.*

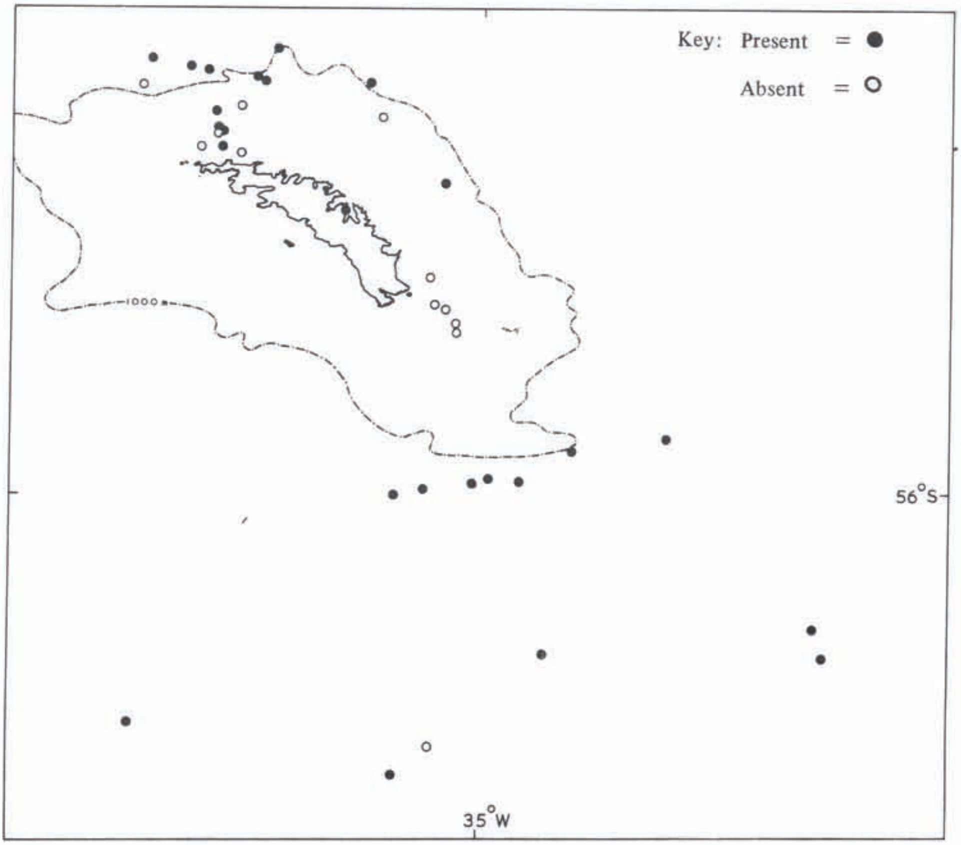

Fig. 2. – Distribution of pelagic phase postlarval *Notothenia neglecta* in Scotia sea from neuston samples

October and November (Scherbich, 1975) but the fingerling phase of development is pelagic in both species and can be found dispersed over the Scotia Sea (Fig. 2).

At South Georgia, *N. neglecta* fingerlings were evident at the nearshore coastal fringe from late December and *N. rossii* were observed in the same habitat from late January where both species metamorphose from the pelagic to demersal phase of their life cycle (Burchett, 1979). The juvenile development thereafter takes place in coastal waters and *N. neglecta* matures in the same habitat after an average of 7-8 years growth (Everson, 1970), whereas *N. rossii* migrates offshore to mature after 5-7 years growth. There is some debate as to whether the *N. rossii* fingerlings which return to coastal waters have undergone one summers growth (North *et al*, 1980) or perhaps another summers growth (Freytag, 1980), and it seems probable that if the fingerlings fail to find a suitable coastal environment in which to metamorphose then this process will be delayed. Observations of the occurrence of fingerling *N. neglecta* and *N. rossii* in the Cumberland Bay region of South Georgia indicate that this immigration is normally confined to about a two month period with a distinct peak lasting about two weeks. Continuous recruitment to the juvenile population throughout the year might be expected if delayed metamorphosis were taking place and this has not been observed at South Georgia.

METHODS

Both culture experiments were carried out in laboratory aquaria. At Signy Island the aquarium system was in continuous circulation with the open sea where the ambient temperature varied from −1.8° C at the beginning of the experiment (June) to −1.0°C at the end (November). The laboratory aquaria were warmer than the ambient sea water temperature by 0.3°C to 0.8°C. At Grytviken, South Georgia the aquaria were in a closed circuit system which was intermittantly replenished from the sea and used under-gravel filters to maintain the water quality. A temperature of +2° to +3°C was maintained throughout the duration of the experiment.

Adult specimens in spawning condition were collected during June at both localities using trammel nets. The females were stripped of ova into clean plastic containers and then the milt from the males mixed the ova by swirling.

At Signy Island the ova were left from two hours for fertilization to take place then transferred to fine mesh plastic bags suspended in running water. After a further week the developing ova were transferred to perforated perspex trays suspended in aquaria for the duration of the experiment. Dead or moribund eggs were removed at regular intervals and subsamples of the eggs and developing embryos were made at one to three week intervals and fixed in Smith's dichromate preservative.

At Grytviken, the fertilized ova were maintained in perforated plastic holding trays suspended in tanks where the water was circulated by air-lift. The eggs were divided between illuminated and darkened holding tanks. Dead and moribund ova or embryos were removed at regular intervals and whenever fungal infections appeared to be developing, the cultures were treated with remedial doses of the antibiotics Streptomycin and Penicillin G. Subsamples of eggs and developing embryos were taken at regular intervals and preserved in 10 % (v:v) formaldehyde teleost saline.

RESULTS

Previous observations of newly fertilized eggs of *Harpagifer* sp. at Signy Island and *Parachaenichthys georgianus* at South Georgia had shown that the eggs of these species increase in volume and become adhesive, sticking together in a mass on the sea floor. Daniels (1978) noted similar accumulations of eggs together with nest building and brood protection in *Harpagifer* sp. at Arthur Harbour, Antarctic Peninsula. The eggs of *N. neglecta* when fertilized did not swell or become adhesive but remained buoyant. The developing embryos all became negatively buoyant during the experiment at Signy Island after 14 days whereas those in the experiment at South Georgia floated throughout the whole period of development. The result of the Signy Island experiment is more likely to parallel development in the field because this was carried out using water taken directly from the open sea and at the same salinity as nearshore waters. The embryos in the experiment at South Georgia were maintained in closed circuit aquaria where the density of the sea water is often elevated by evaporation. However knowledge of whether the eggs and developing embryos normally float throughout development or rapidly become negatively buoyant in the field is important to assessing the distribution of the species and the normal habitat in which early development takes place.

Table I shows the sequence of the development of the cultures at both localities. All the ova and embryos maintained in the darkened tanks at South Georgia died after one month and these are omitted from the observations. Development from fertilization to first hatching took about 150 days at the colder locality at Signy Island and 103 days at South Georgia. Slower development at the colder sites was to be expected since the total period of development is often closely correlated with temperature. Figures 3 and 4 illustrate the stages of development during both experiments. Newly hatched larval fish were 10-14 mm long.

Attemps were made to catch larval *N. neglecta* in the field during November in the same season that the cultures were carried out at Signy Island but these failed to yield specimens. Subsequent collections have produced postlarval specimens 15 mm long in early December and postlarval *N. rossii* 16-18 mm long in January from the coastal waters of both Signy Island and South Georgia.

Since these initial experiments demonstrated that the technique could be used with Antarctic species further attemps to confirm the observations with *N. neglecta* and extend them to other accessible species such as *Notothenia (Trematomus) hansoni* have met with limited success and a more detailed investigation awaits suitable opportunity in the futur ; meanwhile opportunistic studies continue at Signy Island.

TABLE I. – CHRONOLOGY OF *NOTOTHENIA NEGLECTA* CULTURE EXPERIMENTS

MONTH	LOCALITY	
	SOUTH GEORGIA (2-3°C)	SIGNY ISLAND (–1.8° to –1.0°C)
JUNE	Fertilization (29th)	Fertilization (5th) Gastrulation in progress, embryonic axis obvious
JULY	Gastrulation progressing Notochord visible 30 somite stage	Notochord visible 30 somite stage: cephalic, thoracic and caudal regions clearly visible
AUGUST	Eyes visible and pigmented	
SEPTEMBER	Chromatophores on head and heart-beat visible Chromatophores extending down body: 9 mm long Embryos dark dorsally, gut wall pigmented	Eyes pigmented: organs, heart, gut and bladder obvious: 7 mm long. Chromatophores visible on head
OCTOBER	FIRST HATCH (10th) 103 days 12-14 mm long	Chromatophores extending down body Developing: caudal fin-rays, eyes, musculature and gut wall pigmented
NOVEMBER	HATCH 50 % 127 days	HATCH 12.5 mm long 150 days

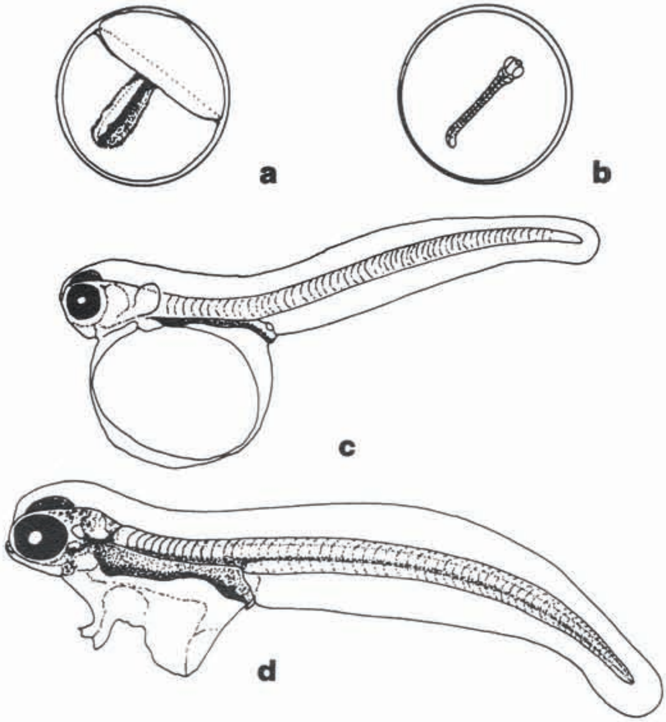

Fig. 3. – Selection of stages during development of *Notothenia neglecta* at Signy Islands, South Orkney Islands

a) Ova, gastrulation in progress 24 days after fertilization
b) Ova, 30 somite stage, 47 days
c) Embryo, 7 mm, removed from ova, 93 days
d) Embryo, 10.5 mm, removed from ova, 138 days

DISCUSSION

How then does the protracted period of development from the fertilized egg to hatching compare with the known elements of the life cycle and the collections of the later stages of development from the field ? Could larvae hatched in October or November become the recruits to the juvenile population in February to April ?

Ichthyoplankton collections during 1978 and 1980 showed that pelagic fingerlings of *N. neglecta* and *N. rossii* were distributed widely over the Scotia Sea (Fig.2). Meristic data for *N. neglecta*, together with the data from postlarval specimens and the hatching data from the culture experiments were compared for each month (Fig. 5). Extrapolation of the perceived growth curve for the fingerlings during the period January to April to the hatching data demonstrates that the growth from hatching to fingerling during that interval does not require anomalous growth rates and so could be achieved during the same summer season. That observation is confirmed by North (1980).

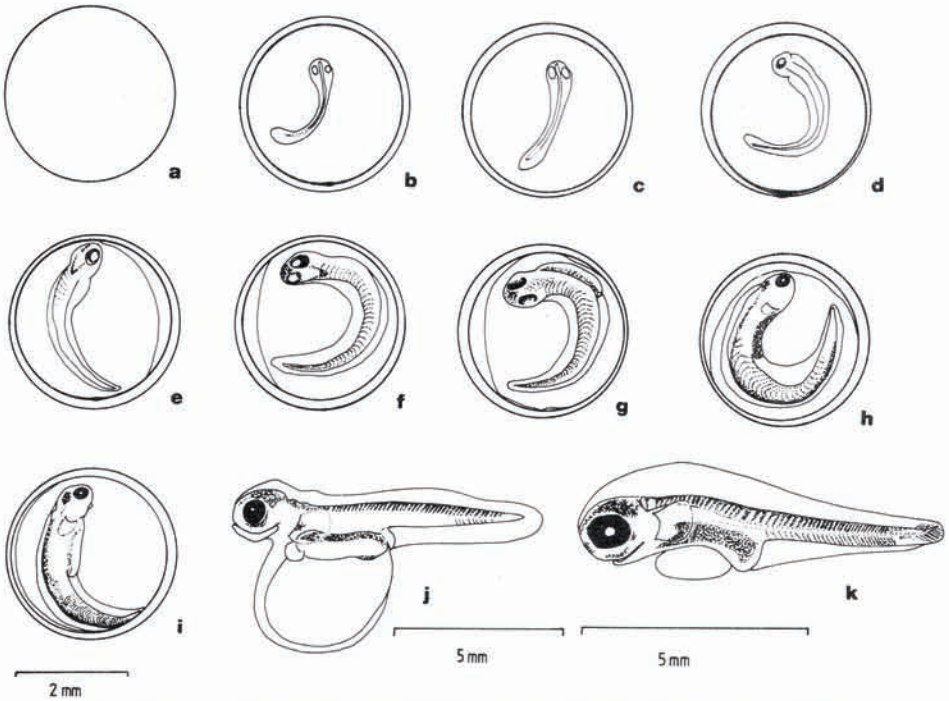

Fig. 4. – Selection of stages during development of *Notothenia neglecta* at South Georgia

a) Ova, 19 days after fertilization
b) Embryo, 24 days
c) Embryo, 35 days
d) Embryo, 45 days
e) Embryo, 58 days
f) Embryo, 65 days
g) Embryo, 74 days
h) Embryo, 85 days
i) Embryo, 96 days
j) Larva, 102 days, at hatching
k) Larva, 127 days

Haemoglobinlessness or reduced haemoglobin are features of some Nototheniiform fish (Everson and Ralph, 1968 ; Barber *et al*, 1981). The use of a haem pigment for oxygen transport is a relatively early feature of the embryonic development in temperate marine and freshwater teleosts. However, an interesting aspect of the development of *N. neglecta* was that no haem pigment was observed during the development to hatching at Signy Island (Twelves, 1970). Examination of *N. neglecta* fingerlings collected during 1978 and 1980 demonstrated that this species has functional erythrocytes at this stage and so the dependence on a haemoglobin transport mechanism must take place during the postlarval development, presumably as a response to the oxygen demands of an active pelagic phase in the life cycle of this species.

The biology of the early life history of Antarctic fish is still poorly understood and clearly there is considerable scope for research into various reproductive strategies adopted by the Nototheniiform groups and insight into the role of these species in the Antarctic food web. Substantial quantitative data about distribution, occurrence and abundance can be obtained during conventional zooplankton surveys but, because of the highly seasonal nature of the polar environment, more detailed research of behavioural, physiological and reproductive strategies of Antarctic fish require year-round observations at shore-based research stations.

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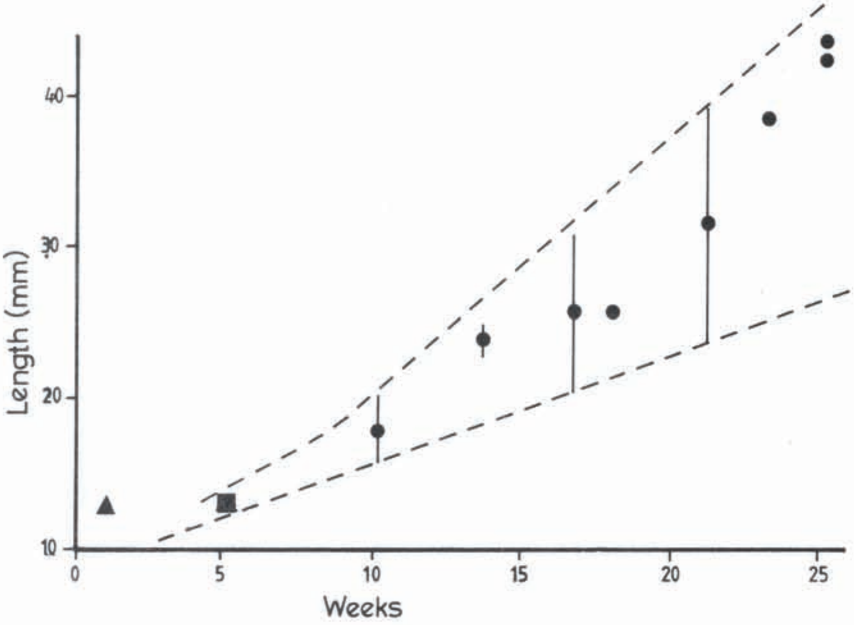

Fig. 5. – Length of *Notothenia neglecta* larvae and postlarvae from ichthyoplankton samples, week 1 = first week october.

Key: Mean length = ●

Range of length = Bar

Hatching length and time South Georgia = ▲

Hatching length and time South Orkney Islands = ■

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